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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/820,695	03/30/2001	Si Yi Li	015290-500	4162

21839 7590 02/27/2004

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EXAMINER

OLSEN, ALLAN W

ART UNIT PAPER NUMBER

1763

DATE MAILED: 02/27/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

## Application No.

09/820,695

## Applicant(s)

LI ET AL.

eb

## Examiner

Allan W Olsen

## Art Unit

1763

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 09 December 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-24 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-24 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 20 March 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_.
- 4) ☐ Interview Summary (PTO-413) Paper No(s) \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

## DETAILED ACTION

### ***Claim Rejections - 35 USC § 112***

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

**Claim 24 is rejected under 35 U.S.C. 112, second paragraph**, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 24 recites the limitations "wherein the bottom electrode ...or the showerhead electrode". There is insufficient antecedent basis for the references to an electrode.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

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**Claims 1-3, 5-7, 9-17 and 19-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent Application Publication 2003/0162407 of Maex et al. (hereinafter, Maex) in view of US Patent 6,485, 988 issued to Ma et al. (hereinafter, Ma).**

Maex teaches etching .25  $\mu\text{m}$  features through a low-k dielectric layer with an oxygen-free plasma that comprises a fluorocarbon (e.g.,  $\text{CF}_2\text{H}_2$ ) and nitrogen. Maex teaches a  $\text{N}_2$ : fluorocarbon flow ratio of at least 2:1. Maex teaches the plasma may also include an inert gas such as Ar. Maex teaches that the layer underlying the low-k material can be silicon carbide, silicon nitride, or titanium nitride. Maex teaches applying the method to a dual damascene process. Maex teaches maintaining a chamber pressure of between 1 mTorr and 5 Torr.

Maex does not teach using a dual frequency parallel plate reactor having a showerhead electrode and a bottom electrode on which the substrate is supported. Maex does not teach a substrate support temperature of  $20^\circ\text{C} - 50^\circ\text{C}$ . Maex does not teach etching to features with a 5:1 aspect ratio.

Ma teaches etching a low-k dielectric material with fluorocarbon etchants such as those that are taught by Maex. Ma teaches that one can expect to achieve the desired results in such a process, regardless of the etching platform, or apparatus, that one used to carry out the process.

It would have been obvious to one skilled in the art to use a dual frequency parallel plate plasma apparatus to carry out the method of Maex because this type of apparatus is among the most widely used plasma apparatus and given the teaching of Ma, the skilled artisan would have a reasonable expectation of success when using this

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common apparatus. It would have been obvious to one skilled in the art to use a substrate temperature of 20°C - 50°C because the skilled artisan would expect this substrate temperature range to result from the set-point temperature of between -10°C and 50°C that is taught by Maex. It would have been obvious to etch features with a 5:1 aspect ratio because this is a typical demand for fabrication processes at the time the invention was made and Maex teaches etching features with a 0.25  $\mu\text{m}$  width into a low-k dielectric layer having a thickness of 1.1  $\mu\text{m}$  which is on the order of the claimed 5:1 aspect ratio.

Maex does not teach an etching selectivity with respect to the overlying and underlying layers of at least 5:1 but this is a result that naturally flows from the claimed process and therefore this result is also expected to be achieved by Maex.

**Claims 4, 8, 18 and 22-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Maex and Ma combination as applied to claim 1 above, and further in view of Jiang.**

Maex does not teach the use of heavier fluorocarbon etchants (i.e.,  $\text{C}_4\text{F}_8$ ,  $\text{C}_5\text{F}_8$ ). Maex does not teach an etchant comprising  $\text{CH}_2\text{F}_2$  combined with an equal or greater amount of  $\text{C}_4\text{F}_8$ .

Jiang teaches that  $\text{C}_4\text{F}_8$ ,  $\text{C}_5\text{F}_8$  and  $\text{CH}_2\text{F}_2$  are functionally equivalent in their capacity as etchants of low-k dielectric materials.

It would have been obvious to one skilled in the art to use  $\text{C}_4\text{F}_8$  or  $\text{C}_5\text{F}_8$  in place of, or in addition to, the  $\text{CH}_2\text{F}_2$  of Maex's etchant because Jiang teaches these compounds are functionally equivalent as etchants of low-k dielectric materials. When

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combining two compounds that individually function as equivalents of one another, it would be obvious to combine equal quantities of each compound.

"It is prima facie obvious to combine two compositions each of which is taught by the prior art to be useful for the same purpose, in order to form a third composition which is to be used for the very same purpose." *In re Kerkhoven* 205 USPQ 1069 (CCPA 1980). Cites *In re Susi* 169 USPQ 423, 426 (CCPA 1971); *In re Crockett* 126 USPQ 186, 188 (CCPA 1960). See also *Ex parte Quadranti* 25 USPQ 2d 1071 (BPAI 1992).

**Claims 1-6, 9-16 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. patent 6,455,411 issued to Jiang et al. (hereinafter, Jiang) in view of US Patent 6,485, 988 issued to Ma et al. (hereinafter, Ma).**

Jiang teaches plasma etching a low-k dielectric layer. Jiang teaches using an etchant comprising a fluorocarbon and a greater amount of nitrogen. The fluorocarbon etchant taught by Jiang include  $C_4F_8$ ,  $C_5F_8$ ,  $C_4F_6$  and  $CH_2F_2$ . Jiang teaches adding Ar to the etchant. Jiang teaches etching low-k dielectric layers (106 and 108) through an overlying patterned layer of SiN (capping layer 110). The patterned SiN functions as an etch mask when the underlying layer of low-k dielectric is etched. Jiang teaches etching a layer of low-k dielectric that is disposed upon an underlying layer of SiC (104). Jiang teaches etching a layer of low-k dielectric material that overlies a barrier layer comprising TaN. Jiang teaches using a fluorocarbon flow rates that is less than 30% of the nitrogen flow rate. Jiang teaches the etched feature is filled with metal. See: column 2, lines 56-58; column 2, line 65 - column 3, line 26; column 3, lines 33-63; column 4, lines 1-2, 26-46.

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Jiang does not teach the type of plasma reactor in which the process is carried out. Jiang does not teach that the process is intended to be carried out only one type of plasma reactor. Jiang does not teach using a dual frequency parallel plate plasma reactor.

Ma teaches etching a low-k dielectric material with fluorocarbon etchants such as those that are taught by Jiang. Ma teaches that one can expect to achieve the desired results in such a process, regardless of the etching platform, or apparatus, that one used to carry out the process.

It would have been obvious to one skilled in the art to use a dual frequency parallel plate plasma apparatus to carry out the method of Jiang because this type of apparatus is among the most widely used plasma apparatus and given the teaching of Ma, the skilled artisan would have a reasonable expectation of success when using this common apparatus.

Regarding claim 18, Jiang teaches an etchant consisting of  $C_4F_8$ ,  $N_2$  and Ar.

Jiang does not teach an etchant that consist essentially of  $C_5F_8$ ,  $N_2$  and Ar.

It would have been obvious to one skilled in the art to use an etchant consisting of  $C_5F_8$ ,  $N_2$  and Ar because Jiang teaches using an etchant consisting of  $C_4F_8$ ,  $N_2$  and Ar and Jiang also teaches that  $C_4F_8$  and  $C_5F_8$  are functional equivalents as the fluorocarbon component of the etchant mixture. The substitution of equivalents is obvious and requires no express motivation as long as the prior art recognizes the equivalency.

**Conclusion**

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Allan Olsen whose telephone number is 571-272-1441. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Greg Mills, can be reached on 571-272-1439. The fax number for TC1700 is 703-872-9306 (non-after finals and after-final). Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (571) 272-1300.

Allan Olsen, Ph.D.  
February 18, 2004

A handwritten signature in black ink, appearing to read 'Allan Olsen', is written over the typed name and date.